Fang, INC. (April, 2020)

Innovative Color Image Sensor

ABSTRACT

In image sensor industry, the word "resolution or spatial resolution" generally refers to the pixel array size (M x N pixels) on the chip, such as 1000 by 1000 pixels or 2000 by 1000 pixels. In order to increase the recoverable frequency bandwidth of the signal, the image sensor manufacturer needs to put more pixels on the sensor chip. Generally speaking, the Bayer filter is currently the mostly popular design used on color image sensors and has periodic sampling patterns in three colors (red, green and blue) .

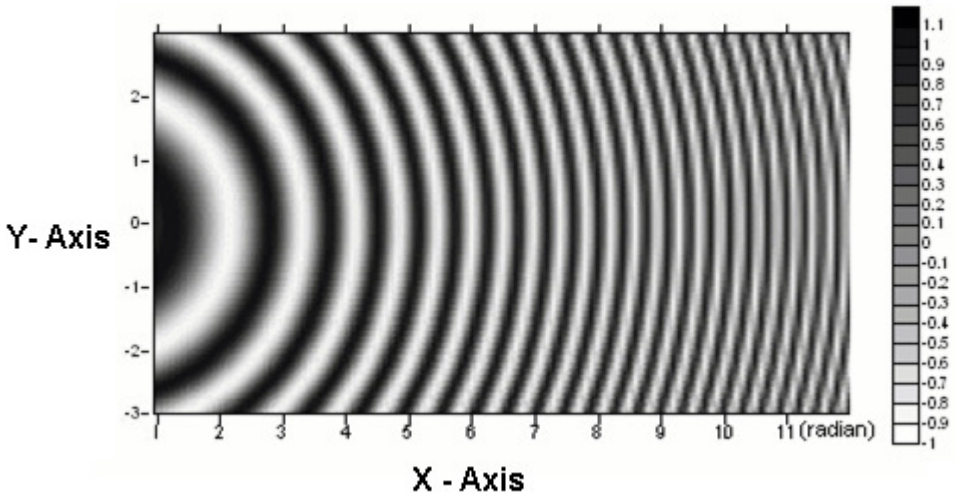
Our company has developed an innovative nonuniform sampling filter design (named Fang filter) for optical, color image sensor The technical merit of the proposal centers around the proprietary Fang filter design which employs random sampling and is radically different from the typical, periodic sampling. In addition, an efficient demosaicing (interpolation) algorithm has been employed. Fang filter design is characterized by having non-periodic sampling patterns for red, green and blue colors respectively. The Fang filter design provides the capability of recovering higher frequency values and widening the recoverable bandwidth in comparison with the standard Bayer filter of the same pixel array (M x N pixels). Thus, Fang filter is less susceptible to aliasing effect and more robust than Bayer filter. This leads directly to the capability of recognizing and identifying the target at a greater distance when the sensor platform is approaching the target, and vice versa. This is a much desired feature for security and surveillance applications. This allows a moving sensor platform to acquire and track the intended target sooner. (The proof is shown and explained in the 3 images included below. We used the mathematical function, "zone-plate" for the demonstration.) It is known that in certain applications monochrome image sensors are chosen over color ones, because the former are able to achieve a slightly higher resolution. But to use Fang filter design can raise the resolution and make color sensors on a par with monochrome sensors.

The challenge for the ongoing research is to suppress noise-like fluctuations that are present in the image generated by using the Fang filter design. Hence, our R & D plan is focused to secure a solution through software simulation work to obtain better image quality. In addition, contacting image sensor makers will be done to secure collaboration for the fabrication of Fang filter. Finally, effort will also be made to bring the innovation closer to commercialization by adding a hardware system integrator on the team.

FIGURE 1

Image pattern of zone-plate
Sine ($x^2 + y^2$)
(A contour plot)

where $1 \leq x \leq 11.9$ and
$-3 \leq y \leq +2.9$

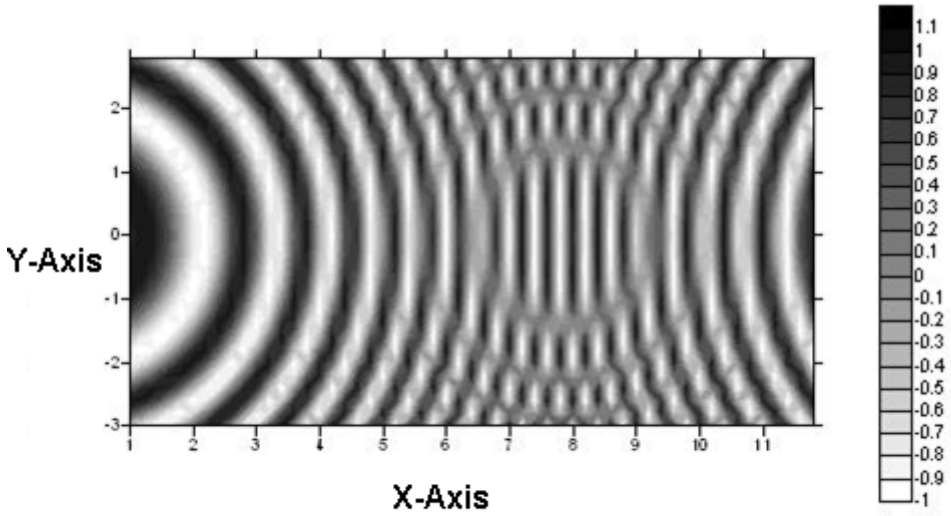


(Total samples 60 x 110 = 6600 are used to generate this figure.
The uniform sampling grid is 60 rows and 110 columns.
The grid size is 0.1 radians by 0.1 radians.
Note that the ring structure is becoming more densely packed
in the area with larger X values. There shows higher frequency.
Both X and Y axis are expressed in “radians”.
The zone-plate function has the values between -1 and +1.)

FIGURE 2

Image pattern of zone-plate
Sine ($x^2 + y^2$)
(A contour plot)

where $1 \leq x \leq 11.9$ and
$-3 \leq y \leq +2.9$

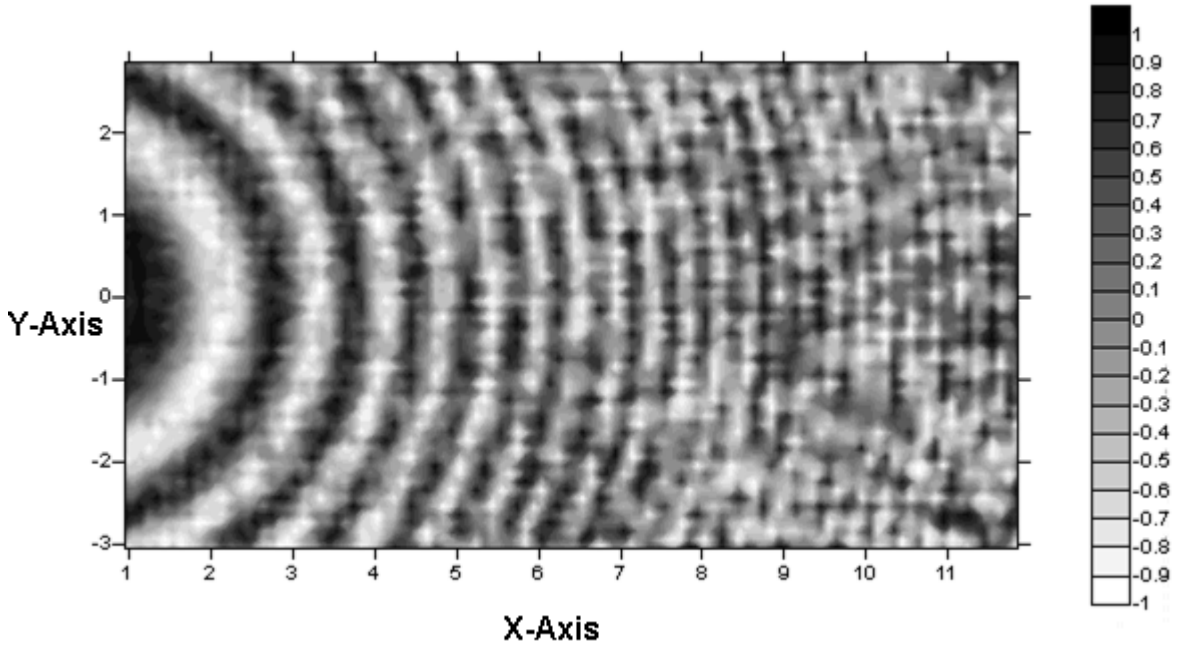


(Total samples 30 x 55 = 1650 are used to generate this figure.
The uniform sampling grid is 30 rows and 55 columns.
The grid size is 0.2 radians by 0.2 radians. Equivalent speaking,
the object distance from the camera in Figure 2 is twice the value of that in Figure 1.
It can be seen that the aliasing effect shows in the area of higher
frequency, namely where X> 7 radians. Because the sampling rate is lower than
what the Nyquist limit requires.)

FIGURE 3

Image pattern of zone-plate
Sine ($x^2 + y^2$)
(A contour plot)

where $0.95 \leq x \leq 11.85$
and $-2.95 \leq y \leq +2.85$



(Total samples 30 x 55 = 1650 are used to generate this figure.
Fang filter is used for the sample locations which are randomly distributed across the image.
The grid size is not fixed. It can be seen in Figure 3 that the aliasing effect shown in Figure 2 has been suppressed even though in the presence of noises. Also, higher frequency ring structures have been recovered where X>7. The result displayed here is applicable to all three colors, red, green and blue. The challenge to our research is to find solution to reduce the noises and improve the image quality of Figure 3 so that it can look like Figure 1.)